



The
Patent
Office

4

GB99/377r

REC'D 16 DEC 1999	
WIPO	PCT

PL/5033/00773



INVESTOR IN PEOPLE

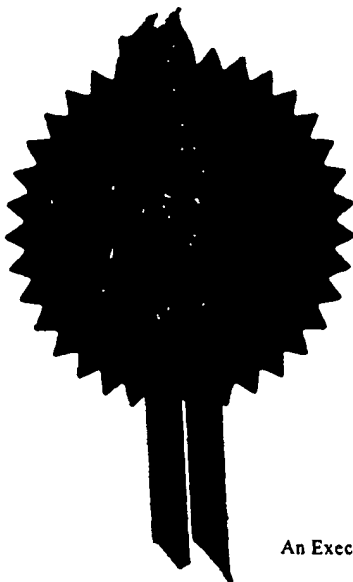
The Patent Office
Concept House
Cardiff Road
Newport
South Wales
NP10 8QQ

I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein.

In accordance with the Patents (Companies Re-registration) Rules 1982, if a company named in this certificate and any accompanying documents has re-registered under the Companies Act 1980 with the same name as that with which it was registered immediately before re-registration save for the substitution as, or inclusion as, the last part of the name of the words "public limited company" or their equivalents in Welsh, references to the name of the company in this certificate and any accompanying documents shall be treated as references to the name with which it is so re-registered.

In accordance with the rules, the words "public limited company" may be replaced by p.l.c., plc, P.L.C. or PLC.

Re-registration under the Companies Act does not constitute a new legal entity but merely subjects the company to certain additional company law rules.



Signed *Andrew Geney*

Dated 6 December 1999

**PRIORITY
DOCUMENT**
SUBMITTED OR TRANSMITTED IN
COMPLIANCE WITH RULE 17 1(a) OR (b)

An Executive Agency of the Department of Trade and Industry

BEST AVAILABLE COPY

Patents Act 1977
(16)

Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form.)

THE PATENT OFFICE
15 NOV 1998
RECEIVED BY HAND

The Patent Office

Cardiff Road
Newport
Gwent NP9 1RH

Fee: £0

1. Your reference	13 NOV 1998	39791	16NOV98 E404796-5 D01631
2. Patent application number (The Patent Office will fill in this part)	9824976.6		POL/77/00 0.00 - 9824976.6
3. Full name, address and postcode of the or of each applicant (underline all surnames)	Mars U.K. Limited 3D Dundee Road Slough Berkshire SL1 4LW		
Patents ADP number (if you know it)	5632260001		
If the applicant is a corporate body, give the country/state of incorporation	United Kingdom		
4. Title of the invention	Body Fat Measurement System		
5. Full name, address and postcode in the United Kingdom to which all correspondence relating to this form and translation should be sent	Reddie & Grose 16 Theobalds Road LONDON WC1X 8PL		
Patents ADP number (if you know it)	91001		
6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and (if you know it) the or each application number	Country	Priority application (If you know it)	Date of filing (day/month/year)
7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application	Number of earlier application		Date of filing (day/month/year)
8. Is a statement of inventorship and of right to grant of a patent required in support of this request? (Answer 'Yes' if: a) any applicant named in part 3 is not an inventor, or b) there is an inventor who is not named as an applicant, or c) any named applicant is a corporate body. See note (d))	YES		

Patents Form 1/77

Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document.

Continuation sheets of this form

Description 8

Claim(s) 2

Abstract 1

Drawing(s) 3 + 3

10. If you are also filing any of the following, state how many against each item.

Priority documents -

Translations of priority documents -

Statement of inventorship and right to grant of a patent (Patents Form 7/77) -

Request for preliminary examination and search (Patents Form 9/77) -

Request for substantive examination (Patents Form 10/77) -

Any other documents (please specify)

11. I/We request the grant of a patent on the basis of this application.

Signature

Date

Reddick & Crane

13 November 1998

12. Name and daytime telephone number of person to contact in the United Kingdom

IAN M LOVELESS
0171-242 0901

Warning

After an application for a patent has been filed, the Comptroller of the Patent Office will consider whether publication or communication of the invention should be prohibited or restricted under Section 22 of the Patents Act 1977. You will be informed if it is necessary to prohibit or restrict your invention in this way. Furthermore, if you live in the United Kingdom, Section 23 of the Patents Act 1977 stops you from applying for a patent abroad without first getting written permission from the Patent Office unless an application has been filed at least 6 weeks beforehand in the United Kingdom for a patent for the same invention and either no direction prohibiting publication or communication has been given, or such direction has been revoked.

Notes

- If you need help to fill in this form or you have any questions, please contact the Patent Office on 0645 500505.
- Write your answers in capital letters using black ink or you may type them.
- If there is not enough space for all the relevant details on any part of this form, please continue on a separate sheet of paper and write "see continuation sheet" in the relevant part(s). Any continuation sheet should be attached to this form.
- If you have answered 'Yes' Patents Form 7/77 will need to be filed.
- Once you have filled in the form you must remember to sign and date it.
- For details of the fee and ways to pay please contact the Patent Office.

BODY FAT MEASUREMENT SYSTEM

The present invention relates to a system for measurement of the percentage of body fat by weight of four legged mammals, in particular domestic cats.

5 Obesity is the most common form of malnutrition in cats, however, the links between obesity and the risk of clinical conditions are not well understood. This is primarily because there is no accepted method for defining obesity or measuring body fat in cats.

10 The body mass index (BMI), which is based only upon measurements of body weight and height, allows objective measurement available for humans. The main techniques available to veterinary practitioners are subjective ones such as the Body Condition Score (BCS) system produced by
15 Latflamme.

We have appreciated the requirement for a simple, objective system for determining the percentage body fat by weight of four legged mammals, in particular cats. In particular, we have appreciated that the system should be
20 reliable and capable of implementation in both technologically simple and complex embodiments. The system should also be easy for inexperienced operators to use.

Accordingly, there is provided a system for measuring the
25 percentage body fat of a four legged mammal, comprising:

- means for measuring a first body dimension having a high correlation with percentage body fat;
- means for measuring a second body dimension having a low correlation with percentage body fat; and

- a look-up table comprising a first storage area for storing entries of the first body dimension, a second storage area for storing entries of the second body dimension and an output area for indicating the percentage body fat determined from a relationship between the first and second body measurements.

The system of the invention has the advantages of being simple to operate, reliable and capable of implementation as a low technological manual system, or a more sophisticated computerised implementation.

In a preferred embodiment the first body dimension is the circumference of the ribcage. This measurement has been appreciated, through experimentation, to be highly correlated to a four legged mammal's percentage body fat. In the embodiment, the second body dimension is a leg index measurement, preferably the length from the achilles to the patella of the hind limb which, we have appreciated, has a low correlation with percentage body fat. The use of the body measurement of high correlation with body fat and one with low correlation increases the accuracy of the determined percentage body fat.

A system embodying the invention will now be described with reference to the accompanying figures in which:-

Figure 1- is a diagrammatic representation of a system embodying the invention;

Figure 2- is a diagrammatic representation of a first look-up table for use in the system of Figure 1; and

Figure 3- is a diagrammatic representation of a second look-up table for use in the system of Figure 1.

The embodiment shown in Figure 1 may be either manually operated, or a computerised system. A first measurement device 10 and a second measurement device 12 are provided to take measurements of, respectively, the ribcage circumference and the leg index measurement [LIM] to provide the results to the look-up table 18. In a computerised embodiment, the measurement devices 10, 12 would provide measurement signals to a computer, storing therein in first, second and output storage areas respectively, ribcage and LIM, and corresponding fat percentage indications. These are shown as storage and determination functions 14 in Figure 1. The results are displayed as an output display 18. The determination algorithm (described later) could be coded in any simple computer language, and is within the common general knowledge of the skilled person, and need not be described here.

A manual representation of the look-up table 18 is shown in Figures 2 and 3. There is shown a first storage area 20, storing first body dimensions (ribcage) measurements, and a second storage area 22, storing second body dimensions (LIM). An output storage area 24 stores an indication of the percentage body fat of a domestic cat as a relationship of the first and second dimensions. The indication is under, normal or overweight in Figure 2. In figure 3, the indication is given as a percentage number.

In appreciating that the system embodying the invention provides a uniquely robust and reliable system for determining the percentage body fat of a cat, a number of experiments were undertaken, as will now be described.

To establish the correlation between body condition score (BCS) and body composition (% body fat) as measured using Dual Energy X-Ray Absorptiometry (DXA), and to compare zoometric measurements with estimates of body condition

score and % body fat using DXA, in order to develop a simple objective method of determining body condition, the following method was adopted.

Zoometric measurements and estimates of BCS (body condition score) and body composition (using DXA), were taken from 60 domestic, short-haired cats, housed indoors. All measurements were taken between 03/03/97 and 22/05/97, by a single observer. In the study, 28 males (all neutered) and 32 females (of which 8 were entire) were used. The average age of the females was 4.92 years and males 3.94 years. The body weights of entire female cats ranged from 2.34 to 4.1 Kg, the neutered female cats from 2.84 to 6.6 Kg and the males 4.2 to 8.18 Kg. Cats had been fed a variety of diets at the time measurements were taken.

The following zoometric measurements were taken from each cat. These were selected because they were considered to represent body condition or had been found from human data to be potentially useful.

- Height: The distance between the ground and the Withers (the top of the shoulder blade or scapula) as measured using a measuring stick. This is a wooden metre ruler with a fixed base, perpendicular to the rule and a sliding wooden bar.
- Chest Dept: The vertical distance from the top of the capula to the bottom of the chest, using a measuring stick.
- Girth: The circumference at the point of the 4th lumbar vertebrae, just behind the last rib, using a measuring tape.

- Ribcage: The circumference at the point of the 9th rib (5 ribs from the posterior end of the ribcage), using a tape measure.
- Length: The horizontal distance from the breast-bone (manubrium) to the thigh (perineum), using a measuring stick.
- Elbow: Measured on the left elbow using a calliper. It is the distance between the lateral epicondyle of the humerus and the medial epicondyle of the humerus.
- Front Long Bone: The length of the humerus, from the proximal ulnar epiphysis to the distal radial epiphysis, using a measuring stick.
- Leg index measurement [LIM]: The distance between the Patella and the achilles, using a measuring stick;

All measurements were taken from the left hand side of the cat whilst it was standing with its legs perpendicular to the ground and with its head up and looking forward. Cats were weighed prior to taking the measurements, which were taken in a fasted state. Five replicates of each measurement were taken on the same day.

The Purina Body Condition Score (Laflamme, 1998) was used as a subjective assessment of body condition. The cat was given a score on a nine point scale, which ranged from 1 for emaciated to 9 for morbidly/grossly obese, although experienced assessors are able to grade cats to 0.5 of a scale. A cat with a BCS score of 5 was considered to be ideal. This scoring system was based on a variety of

features, which included palpability of the ribs, presence of a discernible waist and abdominal tuck, and evidence of bony prominence and fat deposits on the lumbar area and base of the tail.

The percentage body fat was measured by dual energy X-ray absorptiometry, using a Hologic QDR 1000/W densitometer. They were anaesthetised using Domitor (0.1ml/Kg) and recovery induced with Antisepen.

Eight inexperienced observers each made an estimate of BCS and took their replicates of each zoometric measurement on the same seven cats, in order to test for inter-observer variability in predicting body condition.

Each Zoometric measurement was compared with % body fat because this represented the most objective estimate of body composition. The most significant correlation with % body fat was for ribcage. This factor is more likely to be affected by an increase in body weight or obesity. It may therefore be considered to provide an estimate of % body fat, or 'fatness'. The lowest correlation's with % body fat were found for the LIM and height measurements ($r^2 < 15.4\%$). This is a low correlation. These may therefore be considered to be measurements of stature which are relatively unaffected by changes in % body fat.

We appreciated that a system could be devised using this data to provide a simple system for measuring the percentage body fat of cats. The formula that describes the most variation in percentage body fat and is biologically meaningful is:

$$Fat = \left[\frac{\left(\frac{Ribcage}{0.7067} - LIM \right)}{0.9156} \right] - LIM$$

The mean, standard deviation and coefficient of variation were determined for each of the 60 cats from the five replicates made for each zoometric measurement by the experienced observer. The mean and median coefficient of variation (CV) for each zoometric measurement was less than 10% suggesting that the intra-observer repeatability was low and that a single measurement would be needed in future (see table below).

CV for each zoometric measurement made by a single experienced assessor.

	Coefficient Of Variation (%)			
	Mean	Median	Min	Max
Weight	2.30	1.19	0	12.78
Girth	1.96	1.57	0.27	6.74
Ribcage	3.03	2.6	0.5	15.57
Height	1.49	0.93	0.18	8.94
Chest Dept	3.54	3.34	1.36	9.62
Length	2.37	2.15	0.22	6.26
Elbow	4.28	4.35	0	9.56
Front Long Bone	2.11	1.77	0	5.26
Back Long Bone	2.5	2.16	0.33	8.19

The cats included in this study encompassed a wide range of body composition and age, but were of a single population of related genetic domestic short-haired stock. They may therefore form a representative sub-sample of the domestic cat population in general.

BCS was significantly correlated with % body fat, when measured using DXA ($r = 73.4\%$, $p < 0.01$) and gave a reasonable prediction of % fat. However, the correlation was lower than that reported by Laflamme (1998) where $r = 83.5\%$, although 48 cats were used in this study, of which only 4 individuals had a BCS less than 5. Using the BCS

system in this study, cats which were of ideal body condition (BCS = 5) had between 15 and 30% body fat. Cats which were considered to be underweight (BCS < 5), were less than 20% fat and those which were overweight (BCS > 6) were more than 30% fat. Whilst these data sets are relatively small (underweight group = 7 cats, ideal = 8 cats) it gives an indication of the cut off points that might be used for these major categories of % body fat for cats. The largest discrepancy between % body fat and BCS occurred for those animals considered to have a BCS between 5 and 6. This may indicate the problems of correctly identifying animals of 'ideal' condition when animals differed greatly in stature. Animal stature, particularly of very large or small cats was considered to be a determining factor in the large variation of BCS assigned to individual cats by different observers, resulting in a relatively high CV of 15.3%. It would appear that the BCS type of assessment is truly subjective.

By comparison zoometric measurements, and ribcage in particular ($r = 82.9\%$) were more highly correlated with % body fat than the BCS system. This is a high correlation.

The high level of repeatability for the ribcage and LIM measurements of cats and the high correlation between the zoometric model and % body fat suggests that this objective measurement is a more appropriate tool for determining body composition of cats than BCS. In addition it is also non-invasive, requires little training to achieve an acceptable level of repeatability and requires only a metric tape measure. This makes this method available for all veterinary practitioners and cat owners.

CLAIMS

1. A system for measuring the percentage body fat of a four legged mammal, comprising:
 - means for measuring a first body dimension having a high correlation with percentage body fat;
 - means for measuring a second body dimension having a low correlation with percentage body fat; and
 - a look-up table comprising a first storage area for storing therein entries of the first body dimension, a second storage area storing therein entries of the second body dimension and an output storage area storing an indication of the percentage body fat determined from a relationship between the first and second body measurements.
2. A system according to Claim 1, wherein the first body measurement is the circumference of the ribcage, taken at the 9th rib.
3. A system according to Claim 1 or Claim 2, wherein the second body measurement is a leg index measurement, which is the length of the hind limb measured between the patella and the achilles.
4. A system according to any preceding claim, wherein the output storage area provides an indication of whether the mammal is under, normal or overweight.
5. A system according to any preceding claim, wherein the output storage area provides a numerical percentage body fat.

6. A system according to any preceding claim, wherein the relationship between the percentage body fat and first and second body dimensions is given by the equation:-

$$PercentageBodyFat = \left[\frac{\left(\frac{R}{C_1} - L \right)}{C_2} \right] - L$$

- 5 where R = ribcage circumference
 L = leg index measurement
 C1 = constant
 C2 = constant
7. A lookup table for use in the system of any
10 proceeding claim, comprising:
- a first storage area storing therein entries of the first body dimension;
 - a second storage area storing therein entries of the second body dimension; and
 - 15 - an output storage area storing an indication of percentage body fat determined from a relationship between the first and second body measurements.
8. A system substantially as herein described and with reference to the accompanying figures.
- 20 9. A lookup table substantially as herein described and with reference to the accompanying figures.

Abstract

BODY FAT MEASUREMENT SYSTEM

A body fat measurement system for mammals includes means
5 for measuring first and second body dimensions having a
high correlation with body fat and low correlation
respectively. A lookup table provides an output of the
percentage body fat on input of the first and second
dimensions.

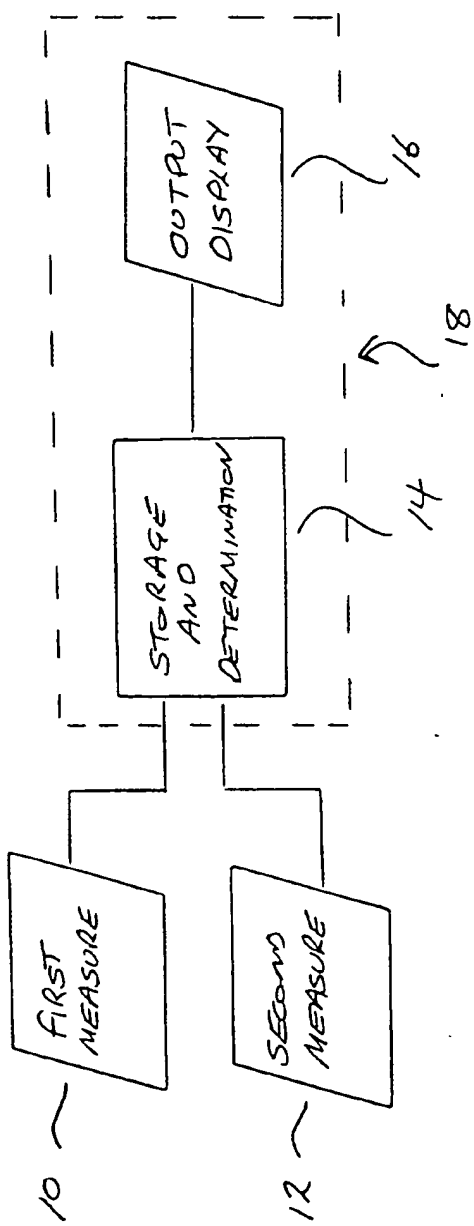


Fig 1

60
58
56
54
52
50
48
46
44
42
40
38
36
34
32
30
28
26
24
22
20

Rib cage (cm)

18 →

20 ~

Normal weight

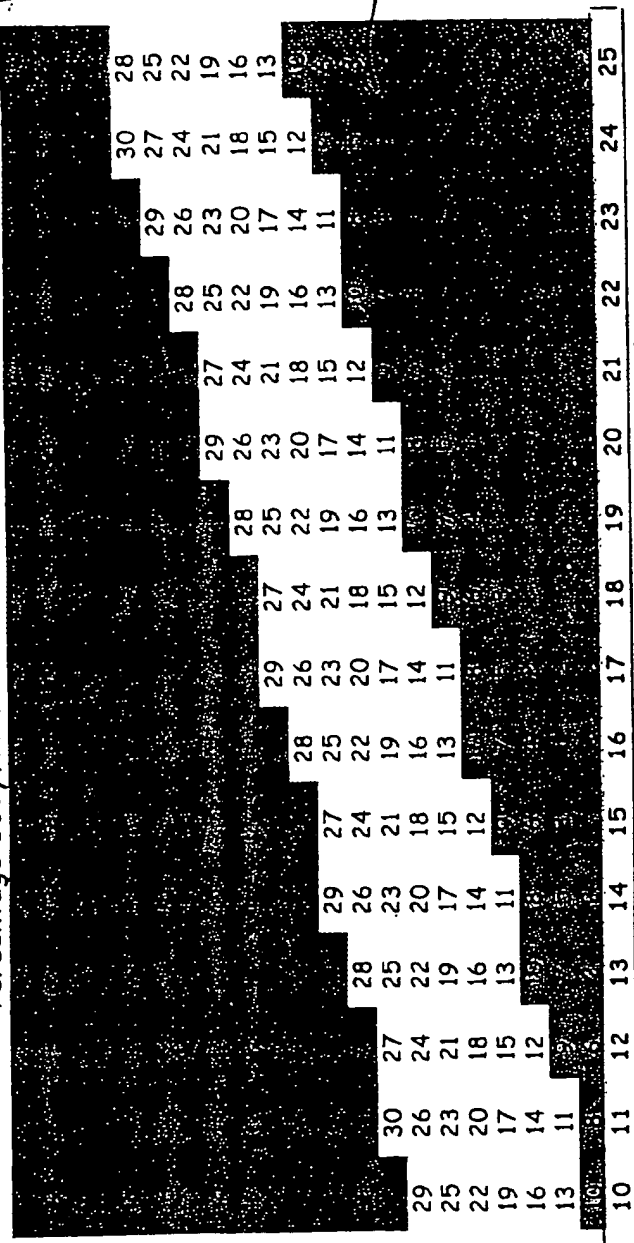
24

Back longbone (cm)

22

fig 2

Percentage bodyfat content



Rib cage (cm)

Back longbone (cm)

Key

Normal weight

Over weight

Under weight

Fig 3

18 →

20 ~

22

24

2/3

Abstract

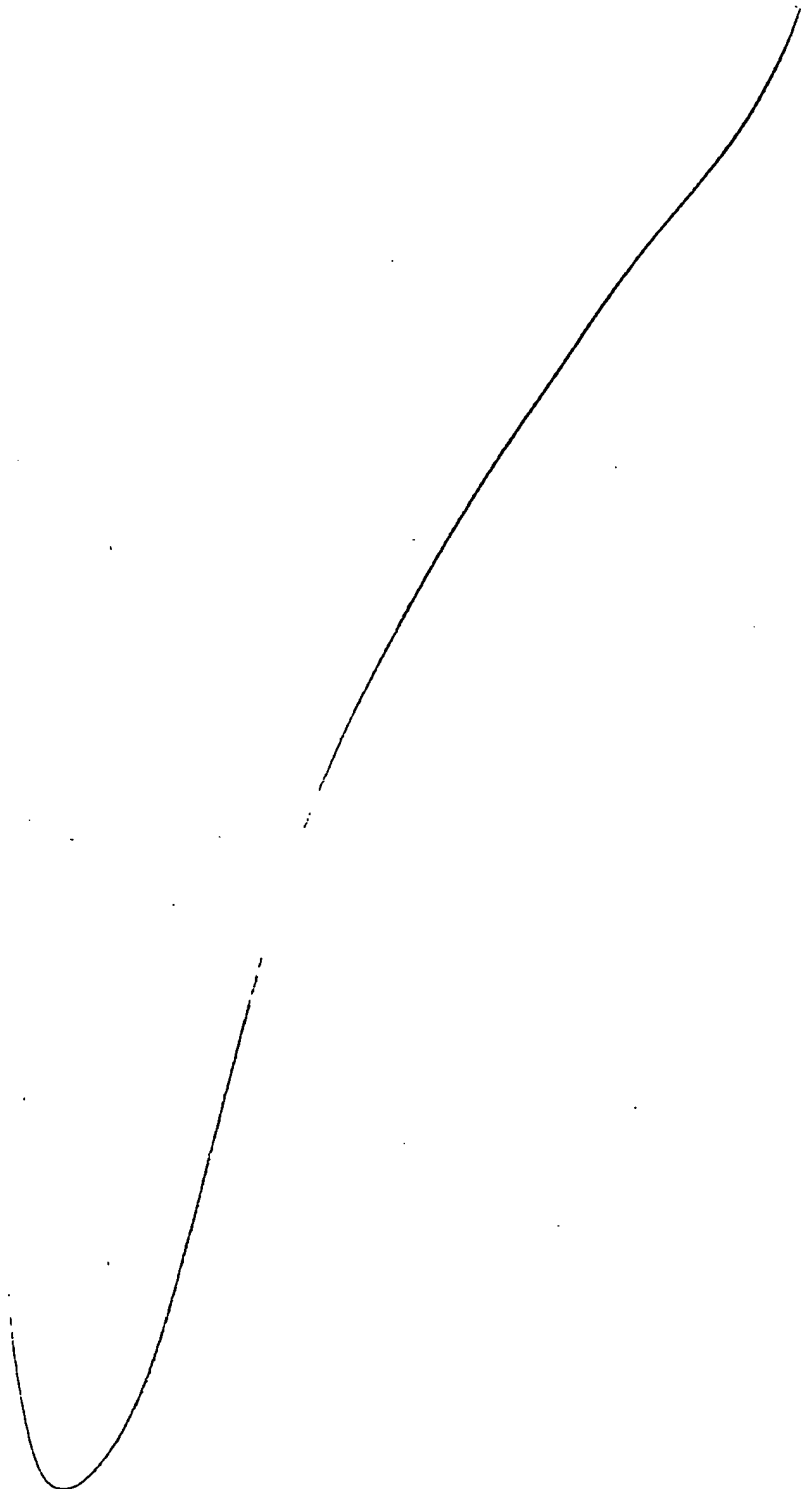
BODY FAT MEASUREMENT SYSTEM

A body fat measurement system for mammals includes means for measuring first and second body dimensions having a high correlation with body fat and low correlation respectively. A lookup table provides an output of the percentage body fat on input of the first and second dimensions.

PCT/GB99/03775

12/11/99P

Reddie & Grace



**This Page is Inserted by IFW Indexing and Scanning
Operations and is not part of the Official Record**

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☐ **BLACK BORDERS**
- ☐ **IMAGE CUT OFF AT TOP, BOTTOM OR SIDES**
- ☐ **FADED TEXT OR DRAWING**
- ☐ **BLURRED OR ILLEGIBLE TEXT OR DRAWING**
- ☐ **SKEWED/SLANTED IMAGES**
- ☐ **COLOR OR BLACK AND WHITE PHOTOGRAPHS**
- ☐ **GRAY SCALE DOCUMENTS**
- ☐ **LINES OR MARKS ON ORIGINAL DOCUMENT**
- ☒ **REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY**
- ☐ **OTHER:** _____

IMAGES ARE BEST AVAILABLE COPY.

As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.